Au, Ag, Ta, Mo, Cu, Ni, Cr, Zn, W

.05 or less

DERWENT-ACC-NO: 1999-112566
DERWENT-WEEK: 199911

TITLE: Surface acoustic wave filter for mobile communication apparatus e.g.
portable telephone - obtains normalization film thickness from certain equation
when wavelength of SAW in serial SAW resonator and electrode film thickness of
parallel SAW resonator are set to ~l

PATENT-ASSIGNEE: KYOCERA CORP[KYOC]

PRIORITY-DATA: 1997JP-0140630 (May 29, 1997)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
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APPLICATION-DATA:

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INT-CL_(IPC): H03H009/145; H03H009/25 ; H03H009/64

ABSTRACTED-PUB-NO: JP10335965A

BASIC-ABSTRACT: NOVELTY - When the wavelength, Hp, of the SAW in a serial SAW
resonator, and the electrode film thickness, Hs, of a parallel SAW resonator
are set to lambda , the normalization film thickness, Hp divided by lambda and
Hs divided by lambda , are obtained from the equation 0.01 at most absolute
value of (Hp divided by lambda -Hs divided by lambda) at most 0.1s. DETAILED
DESCRIPTION - The serial SAW resonator has a pair of comb-like electrodes
connected to a serial wiring of a piezoelectric substrate. The parallel SAW
resonator also has a pair of comb-like electrodes connected between the serial
and parallel wirings and ground. CERAMICS AND GLASS - The piezoelectric

substrate consists of LiTaO3 crystal.

USE - For mobile communication apparatus e.g. portable telephone.

ADVANTAGE - Secures sufficient double-sided frequency margin.
DESCRIPTION OF
DRAWING(S) - The drawing shows the frequency characteristics of the surface
acoustic wave filter.

CHOSEN-DRAWING: Dwg.1/7

TITLE-TERMS:
SURFACE ACOUSTIC WAVE FILTER MOBILE COMMUNICATE APPARATUS PORTABLE TELEPHONE
OBTAIN FILM THICK EQUATE WAVELENGTH SAW SERIAL SAW RESONANCE ELECTRODE FILM
THICK PARALLEL SAW RESONANCE SET

DERWENT-CLASS: U14 U25 V06 W01

EPI-CODES: U14-G; U25-B; V06-K03; V06-K04; V06-K05; W01-C01D3C;

SECONDARY-ACC-NO:
Non-CPI Secondary Accession Numbers: N1999-082437

* NOTICES *

The Japanese Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] LiTaO3 The in-series surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the in-series wiring on the piezo-electric substrate which consists of a crystal. The parallel surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the aforementioned in-series wiring and the parallel wiring during a grounding, and grow into them. It is a ladder type surface-acoustic-wave VCF. the electrode thickness of the aforementioned in-series surface-acoustic-wave resonator Hs, The surface-acoustic-wave VCF characterized by these standardization thickness Hp/lambda and Hs/lambda being 0.01 <=|Hp/lambda-Hs/lambda|<=0.1 when wavelength of Hp and a surface acoustic wave is set to lambda for the electrode thickness of the aforementioned parallel surface-acoustic-wave resonator.
[Claim 2] LiNbO3 The in-series surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the in-series wiring on the piezo-electric substrate which consists of a crystal. The parallel surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the aforementioned in-series wiring and the parallel wiring during a grounding, and grow into them. It is a ladder type surface-acoustic-wave VCF. the electrode thickness of the aforementioned in-series surface-acoustic-wave resonator Hs, The surface-acoustic-wave VCF characterized by these standardization thickness Hp/lambda and Hs/lambda being 0.01 <=Hp/lambda-Hs/lambda<=0.2 when wavelength of Hp and a surface acoustic wave is set to lambda for the electrode thickness of the aforementioned parallel surface-acoustic-wave resonator.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the surface-acoustic-wave VCF built in mobile communication equipments, such as a cellular phone.
[0002]
[Description of the Prior Art] The circuit diagram of the conventional ladder (ladder) type surface-acoustic-wave (by Surface Acoustic Wave, it abbreviates to SAW hereafter) VCF F is shown in drawing 5 . Drawing 5 (a) is [a 2.5 step T type and (c of a 2.5 step pi type and (b))] three step type things. Such ladder type SAW filter (henceforth SAW filter) F is obtained by forming two or more SAW resonators which consist of the ctenidium-like electrodes (henceforth [it is Inter Digital Transducer and] IDT electrode) 1a and 1b of a couple, and the reflectors 2 and 2 prepared in the ends of SAW propagation path of the IDT electrodes 1a and 1b on a piezo-electric substrate (not shown). In addition, for 11a, 11b, and 11c, in (a), an in-series SAW resonator, and 12a and 12b of a parallel SAW resonator and 3 are [an input terminal and 4] output terminals. Similarly, in (b), an in-series SAW resonator, and 14a, 14b and 14c of 13a, 13b, and 13c are parallel SAW resonators, and an in-series SAW resonator, and 16a, 16b and 16c of 15a, 15b, and 15c are parallel SAW resonators in (c).
[0003] And if SAW resonator produces a resonance on a certain specific frequency and an in-series SAW resonator and a parallel SAW resonator are connected to a ladder type, as shown in drawing 6 (b), it can constitute a band-pass filter. Drawing 6 (a) shows the impedance absolute value |Z|-frequency characteristic of an in-series SAW resonator and a parallel SAW resonator, and the so-called resonance frequency from which an impedance serves as the maximum on a specific frequency, respectively exists. moreover, (a) -- setting -- Hp The electrode thickness of a parallel SAW resonator, and Hs the electrode thickness of an in-series SAW resonator -- it is -- conventional Hp =Hs it was . In addition, in (b), S21 is a parameter proportional to signal level.

[0004]
[Problem(s) to be Solved by the Invention] However, generally all the thicknesss of the electric conduction layer except the pad section for wire bonding were produced as the same from the ground of the number curtailment of membrane formation processes of electric conduction layers, such as IDT electrode. Then, since the shape-factor section determined by the constant peculiar to a piezo-electric substrate material, for example, an electromechanical coupling coefficient etc., was loose and large when preparing a predetermined decrement region near the transit frequency band, for example, a 869-894MHz frequency band, sufficient frequency margin was not securable in the standup section or the falling section of a transit frequency band edge. The aforementioned shape-factor section is the main fraction of the standup section, or the main fraction of the falling section, and is an about -3.5dB - about -20dB field.
[0005] That is, although the shape-factor section is stored in a predetermined specification frequency span (20MHz) and an ideal secures sufficient frequency margin for the both sides in the falling section of the high region side edge section of a transit frequency band as shown in drawing 6 (b), a frequency margin hardly exists in the high region side of the shape-factor section in fact. In this case, whether a frequency margin is narrow and since it did not exist, the following troubles had arisen.
[0006] It is explained using drawing 7 . it is based on this drawing showing the relation between the number of an SAW filter, and the frequency near the shape-factor section, drawing 7 (a) being the case where the frequency margin exists in the both sides of the shape-factor section enough since the shape-factor section (not shown) is steep, and a wave carrying out the parallel displacement of the frequency shaft top by change of the terms and conditions of a manufacture process in this case -- varying (calling it manufacture deflection curvilinear section in drawing) -- it can store in a specification frequency span On the other hand, as shown in drawing 7 (b), though the aforementioned dispersion is almost fixed, since the shape-factor section is gently-sloping and large, a frequency margin does not exist in the both sides of the shape-factor section enough, but as a result, a specification frequency span becomes narrow relatively to the aforementioned dispersion, and the product (specification out article) which jumps out of the inside of a specification frequency span for the aforementioned dispersion comes out. Conventionally, such a specification out article was generated about 30%.
[0007] Therefore, this invention raises the steep nature of the shape-factor section in the standup section or the falling section of a transit frequency band edge, secures sufficient frequency margin for the both sides of the shape-factor section, and, as a result, aims at canceling that a frequency varies by change of the terms and conditions of a manufacture process, and a specification out article is generated.

[0008]
[Means for Solving the Problem] The surface-acoustic-wave VCF of this invention is LiTaO3. The in-series surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the in-series wiring on the piezo-electric substrate which consists of a crystal. The parallel surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the aforementioned in-series wiring and the parallel wiring during a grounding, and grow into them. It is a ladder type surface-acoustic-wave VCF. the electrode thickness of the aforementioned in-series surface-acoustic-wave resonator Hs, When wavelength of Hp and a surface acoustic wave is set to lambda for the electrode thickness of the aforementioned parallel surface-acoustic-wave resonator, It is characterized by these standardization thickness Hp/lambda and Hs/lambda being 0.01 <=|Hp/lambda-Hs/lambda|<=0.1, and the steep nature of the standup section of a transit frequency band edge or the falling section is raised by such configuration.
[0009] Moreover, the surface-acoustic-wave VCF of this invention is LiNbO3. The in-series surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the in-series wiring on the piezo-electric substrate which consists of a crystal. The parallel surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the aforementioned in-series wiring and the parallel wiring during a grounding, and grow into them. It is a ladder type surface-acoustic-wave VCF. the electrode thickness of the aforementioned in-series surface-acoustic-wave resonator Hs, When wavelength of Hp and a surface acoustic wave is set to lambda for the electrode thickness of the aforementioned parallel surface-acoustic-wave resonator, it is characterized by these standardization thickness Hp/lambda and Hs/lambda being 0.01 <=Hp/lambda-Hs/lambda<=0.2.
[0010] Moreover, the aforementioned piezo-electric substrate is LiTaO3 of 36 degreeY cut-X propagation preferably. LiNbO3 of a crystal or 64 degreeY cut-X propagation It consists of a crystal.
[0011]
[Embodiments of the Invention] Drawing 1 explains this invention. This drawing (a) is the electrode layer thick Hp of a parallel SAW resonator about the electrode layer thick Hs of an in-series SAW resonator. The graph of the |Z|-frequency characteristic when making it thin, The graph of the filter shape in the case of (b) being a thing corresponding to (a) and establishing a predetermined decrement region in the high region side of a transit frequency band, (c) is the electrode layer thick Hp of a parallel SAW resonator. Electrode layer thick Hs of an in-series SAW resonator The graph of the |Z|-frequency characteristic when making it thin and (d) are the things corresponding to (c), and are the graph of the filter shape in the case of establishing a predetermined decrement region in the low-pass side of a transit frequency band.
[0012] It sets to this invention and they are Hs and Hp. It is desirable to make it as thick as possible, and this is because the degree of steepness when deltaf=fa-fr (fa:antiresonant frequency, fr:resonance frequency) of SAW resonator becomes small and constitutes an SAW filter will improve if an electrode thickness is thickened, as shown in drawing 3 and the drawing 4 . It is data of SAW resonator of transposition width-of-face 50lambda (lambda is the wavelength of SAW) of 50 pairs of logarithms, and IDT electrode. in addition, the drawing 4 -- IDT electrode -- For the black dot mark, a piezo-electric substrate is LiNbO3 of 64 degreeY cut-X propagation. Although it consists of a crystal, for the graph of a deltaf-(aluminum) electrode layer thick H property, and the white square mark, a piezo-electric substrate is LiTaO3 of 36 degreeY cut-X propagation. Although it consists of a crystal, it is the graph of a deltaf-(aluminum) electrode layer thick H property.
[0013] However, Hs and Hp Hs =Hp If it is simultaneously made thicker than the former in the status, the frequency margin in narrowing and a transit frequency band will also decrease to transit frequency bandwidth. Therefore, if it is the case where a decrement region is set to the low-pass side near the transit frequency band, or a high region side and it is the direction with a decrement region, for example, a high region side, it is the electrode layer thick Hs of an in-series SAW resonator. Thickening is desirable and it improves only the degree of steepness of the high region side edge section of a transit frequency band in that case.
[0014] Moreover, a piezo-electric substrate is LiTaO3. When it consists of a crystal, it is related with standardization thickness Hp/lambda and Hs/lambda (lambda is the wavelength of SAW). It is referred to as 0.01 <=|Hp/lambda-Hs/lambda|<=0.1 and a control of a thickness is difficult at |Hp/lambda-Hs/lambda|<0.01. Moreover, the effect of this invention is not demonstrated, it is easy to shift from the value (50ohms) which the impedance in the transit frequency band of an SAW filter should adjust with an external circuit in |Hp/lambda-Hs/lambda|>0.1, therefore the frequency deviation in a transit frequency band becomes large. Preferably, being referred to as 0.05 <=|Hp/lambda-Hs/lambda|<=0.1 is good.
[0015] A piezo-electric substrate is LiNbO3. It is referred to as 0.01 <=Hp/lambda-Hs/lambda<=0.2 when it consists of a crystal. In Hp/lambda-Hs / lambda< 0.01, a control of a thickness is difficult, the effect of this invention is not demonstrated, it is easy to shift from the value (50ohms) which the impedance in the transit frequency band of an SAW filter should adjust with an external circuit in Hp/lambda-Hs / lambda> 0.2, therefore the frequency deviation in a transit frequency band becomes large. Preferably, being referred to as 0.05 <=Hp/lambda-Hs/lambda<=0.1 is good.
[0016] The SAW filter of this invention is a ladder type thing which the in-series SAW resonators 11a, 11b, and 11c which have IDT electrode of a couple are connected to an in-series wiring, and the parallel SAW resonators 12a and 12b which have IDT electrode of a couple are connected to the aforementioned in-series wiring and the parallel wiring during a grounding, and grows into them, as shown in drawing 5 (a). Moreover, it is applicable not only to the 2.5 step pi type of drawing 5 (a), the 2.5 step T type of (b), and the three step type of (c) but an one step type or the thing which made multi-stage connection more.
[0017] In this invention, it consists of aluminum or an aluminum alloy (an aluminum-Cu system, aluminum-Ti system, etc.), especially aluminum has high excitation luminous efficacy, and since a material cost is low, IDT electrode and the reflector of SAW resonator have it. [desirable] Moreover, IDT electrode is formed by the thin film forming methods, such as a vacuum

deposition, the sputtering method, or CVD.
[0018] And the width of face of 50 to about 200 and an electrode finger is suitable for the logarithm of IDT electrode in that the spacing of about 0.1-10.0 micrometers and an electrode finger sets opening width of face's (transposition width of face's) of about 0.1-'s10.0 micrometers' and an electrode finger to about 10-'s150 micrometers acquiring the expected property as a resonator or a VCF. Moreover, if piezoelectric material, such as a zinc oxide and an aluminum oxide, is formed between the electrode fingers of IDT electrode, the resonance luminous efficacy of SAW improves and is suitable.
[0019] As a piezo-electric substrate for SAW filters, it is LiTaO3 of 36 degreeY cut-X propagation. LiNbO3 of a crystal and 64 degreeY cut-X propagation LiB4 O7 of 45 degreeX cut-Z [besides a crystal] propagation An electromechanical coupling coefficient is [a crystal etc.] large, and, for a parvus reason, a group-delay temperature coefficient is desirable. The thickness of a piezo-electric substrate has about 0.3-0.5 goodmm, a piezo-electric substrate becomes brittle in less than 0.3mm, and a material cost becomes large in 0.5mm **.
[0020] In this way, this invention raises the steep nature of the shape-factor section in the standup section or the falling section of a transit frequency band edge, sufficient frequency margin for the both sides of the shape-factor section is secured, and, as a result, it has a high yield and the operation effect of considering as the thing of a low cost.
[0021] In addition, this invention is not limited to the above-mentioned operation gestalt, and the various change in within the limits which does not deviate from the summary of this invention does not interfere at all.
[0022]
[Example] The example of this invention is explained below. SAW filter F of the 2.5 step pi type of drawing 5 (a) was produced by following processes (1) - (5).
[0023] (1) LiTaO3 of 36 degreeY cut-X propagation On the wafer of the piezo-electric substrate which consists of a crystal, the resist was applied, the adhesion exposure machine using the ultraviolet-rays (Deep-UV) light source performed photo lithography, and the negative pattern of much SAW filter F was formed.
[0024] (2) On the aforementioned negative pattern, aluminum was formed with the electron-beam-evaporation machine.
[0025] (3) The lift off of the pattern of unnecessary aluminum was carried out in resist sublation liquid, and aluminum pattern of SAW filter F was formed.
[0026] (4) The process of (1) - (3) was repeated twice, and it is the standardization thickness Hs of the electrode of an in-series SAW resonator / lambda= 0.06 (Hs = about 2500**, lambda= about 4.4 micrometers), and the standardization thickness Hp of the electrode of a parallel SAW resonator / lambda= 0.08 (Hp = about 3500**), and was made to be set to Hp/lambda-Hs / lambda= 0.02.
[0027] (5) The package lid was put and closed, after having cut into each SAW filter F in the dicing method the wafer which patterning completed, having pasted up in the package for SMD (Surface Mounted Device:surface mount element), having fixed each SAW filter F by the epoxy resin and carrying out the ultrasonic bonding of the pad section of a package, and the pad section of SAW filter F with aluminum wire of 35microphi (diameter of 35 micrometers).
[0028] and the in-series SAW resonators 11a, 11b, and 11c and the parallel SAW resonators 12a and 12b -- 40 pairs and transposition width of face made [the logarithm of the IDT electrodes 1a and 1b] 30lambda (it is the wavelength of SAW and lambda is about 4.4 micrometers), and the number of electrode fingers of reflectors 2 ten by 20, parallel SAW resonator 12a, and 12b side by in-series SAW resonatorsa [11] and 11b and 11c side
[0029] Thus, the filter shape of produced SAW filter F is measured using a network analyzer, and the result is shown in drawing 2 . Drawing 2 (a) is this invention article, and becomes steep [the shape-factor section] compared with the conventional article of (b), the frequency span also becomes below a half and the frequency margin has doubled [more than].
[0030] Therefore, when 1000 SAW filter F was produced, the defective resulting from the aforementioned frequency margin was completely lost, and became about 100% of the yield.
[0031]
[Effect of the Invention] In a ladder type SAW filter, standardization thickness Hs/lambda of the electrode of an in-series SAW resonator and standardization thickness Hp/lambda of the electrode of a parallel SAW resonator this invention by differing with a predetermined value The steep nature of the shape-factor section is raised in the standup section or the falling section of a transit frequency band edge. secure sufficient frequency margin for the both sides of the shape-factor section, as a result, a frequency varies by change of the terms and conditions of a manufacture process, and a specification out article is generated -- preventing -- high -- it has the effect of considering as a yield thing

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[Translation done.]

Field

[The technical field to which invention belongs] this invention relates to the surface-acoustic-wave VCF built in mobile communication equipments, such as a cellular phone.

[Translation done.]

Technique

[Description of the Prior Art] The circuit diagram of the conventional ladder (ladder) type surface-acoustic-wave (by Surface Acoustic Wave, it abbreviates to SAW hereafter) VCF F is shown in drawing 5 . Drawing 5 (a) is [a 2.5 step T type and (c of a 2.5 step pi type and (b))] three step type things. Such ladder type SAW filter (henceforth SAW filter) F is obtained by forming two or more SAW resonators which consist of the ctenidium-like electrodes (henceforth [it is Inter Digital Transducer and] IDT electrode) 1a and 1b of a couple, and the reflectors 2 and 2 prepared in the ends of SAW propagation path of the IDT electrodes 1a and 1b on a piezo-electric substrate (not shown). In addition, for 11a, 11b, and 11c, in (a), an in-series SAW resonator, and 12a and 12b of a parallel SAW resonator and 3 are [an input terminal and 4] output terminals. Similarly, in (b), an in-series SAW resonator, and 14a, 14b and 14c of 13a, 13b, and 13c are parallel SAW resonators, and an in-series SAW resonator, and 16a, 16b and 16c of 15a, 15b, and 15c are parallel SAW resonators in (c).
[0003] And if SAW resonator produces a resonance on a certain specific frequency and an in-series SAW resonator and a parallel SAW resonator are connected to a ladder type, as shown in drawing 6 (b), it can constitute a band-pass filter. Drawing 6 (a) shows the impedance absolute value |Z|-frequency characteristic of an in-series SAW resonator and a parallel SAW resonator, and the so-called resonance frequency from which an impedance serves as the maximum on a specific frequency, respectively exists. moreover, (a) -- setting -- Hp The electrode thickness of a parallel SAW resonator, and Hs the electrode thickness of an in-series SAW resonator -- it is -- conventional Hp =Hs it was . In addition, in (b), S21 is a parameter proportional to signal level.

[Translation done.]

Effect

[Effect of the Invention] In a ladder type SAW filter, standardization thickness Hs/lambda of the electrode of an in-series SAW resonator and standardization thickness Hp/lambda of the electrode of a parallel SAW resonator this invention by differing with a predetermined value The steep nature of the shape-factor section is raised in the standup section or the falling section of a transit frequency band edge. secure sufficient frequency margin for the both sides of the shape-factor section, as a result, a frequency varies by change of the terms and conditions of a manufacture process, and a specification out article is generated -- preventing -- high -- it has the effect of considering as a yield thing

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, generally all the thicknesss of the electric conduction layer except the pad section for wire bonding were produced as the same from the ground of the number curtailment of membrane formation processes of electric conduction layers, such as IDT electrode. Then, since the shape-factor section determined by the constant peculiar to a piezo-electric substrate material, for example, an electromechanical coupling coefficient etc., was loose and large when preparing a predetermined decrement region near the transit frequency band, for example, a 869-894MHz frequency band, sufficient frequency margin was not securable in the standup section or the falling section of a transit frequency band edge. The aforementioned shape-factor section is the main fraction of the standup section, or the main fraction of the falling section, and is an about -3.5dB - about -20dB field.

[0005] That is, although the shape-factor section is stored in a predetermined specification frequency span (20MHz) and an ideal secures sufficient frequency margin for the both sides in the falling section of the high region side edge section of a transit frequency band as shown in drawing 6 (b), a frequency margin hardly exists in the high region side of the shape-factor section in fact. In this case, whether a frequency margin is narrow and since it did not exist, the following troubles had arisen.

[0006] It is explained using drawing 7 . it is based on this drawing showing the relation between the number of an SAW filter, and the frequency near the shape-factor section, drawing 7 (a) being the case where the frequency margin exists in the both sides of the shape-factor section enough since the shape-factor section (not shown) is steep, and a wave carrying out the parallel displacement of the frequency shaft top by change of the terms and conditions of a manufacture process in this case -- varying (calling it manufacture deflection curvilinear section in drawing) -- it can store in a specification frequency span On the other hand, as shown in drawing 7 (b), though the aforementioned dispersion is almost fixed, since the shape-factor section is gently-sloping and large, a frequency margin does not exist in the both sides of the shape-factor section enough, but as a result, a specification frequency span becomes narrow relatively to the aforementioned dispersion, and the product (specification out article) which jumps out of the inside of a specification frequency span for the aforementioned dispersion comes out. Conventionally, such a specification out article was generated about 30%.

[0007] Therefore, this invention raises the steep nature of the shape-factor section in the standup section or the falling section of a transit frequency band edge, secures sufficient frequency margin for the both sides of the shape-factor section, and, as a result, aims at canceling that a frequency varies by change of the terms and conditions of a manufacture process, and a specification out article is generated.

[0008]

[Translation done.]

MEANS

[Means for Solving the Problem] The surface-acoustic-wave VCF of this invention is LiTaO3. The in-series surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the in-series wiring on the piezo-electric substrate which consists of a crystal. The parallel surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the aforementioned in-series wiring and the parallel wiring during a grounding, and grow into them. It is a ladder type surface-acoustic-wave VCF. the electrode thickness of the aforementioned in-series surface-acoustic-wave resonator Hs, When wavelength of Hp and a surface acoustic wave is set to lambda for the electrode thickness of the aforementioned parallel surface-acoustic-wave resonator, It is characterized by these standardization thickness Hp/lambda and Hs/lambda being 0.01 <=|Hp/lambda-Hs/lambda|<=0.1, and the steep nature of the standup section of a transit frequency band edge or the falling section is raised by such configuration.
[0009] Moreover, the surface-acoustic-wave VCF of this invention is LiNbO3. The in-series surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the in-series wiring on the piezo-electric substrate which consists of a crystal. The parallel surface-acoustic-wave resonator which has the ctenidium-like electrode of a couple is connected to the aforementioned in-series wiring and the parallel wiring during a grounding, and grow into them. It is a ladder type surface-acoustic-wave VCF. the electrode thickness of the aforementioned in-series surface-acoustic-wave resonator Hs, When wavelength of Hp and a surface acoustic wave is set to lambda for the electrode thickness of the aforementioned parallel surface-acoustic-wave resonator, it is characterized by these standardization thickness Hp/lambda and Hs/lambda being 0.01 <=Hp/lambda-Hs/lambda<=0.2.
[0010] Moreover, the aforementioned piezo-electric substrate is LiTaO3 of 36 degreeY cut-X propagation preferably. LiNbO3 of a crystal or 64 degreeY cut-X propagation It consists of a crystal.
[0011]
[Embodiments of the Invention] Drawing 1 explains this invention. This drawing (a) is the electrode layer thick Hp of a parallel SAW resonator about the electrode layer thick Hs of an in-series SAW resonator. The graph of the |Z|-frequency characteristic when making it thin, The graph of the filter shape in the case of (b) being a thing corresponding to (a) and establishing a predetermined decrement region in the high region side of a transit frequency band, (c) is the electrode layer thick Hp of a parallel SAW resonator. Electrode layer thick Hs of an in-series SAW resonator The graph of the |Z|-frequency characteristic when making it thin and (d) are the things corresponding to (c), and are the graph of the filter shape in the case of establishing a predetermined decrement region in the low-pass side of a transit frequency band.
[0012] It sets to this invention and they are Hs and Hp. It is desirable to make it as thick as possible, and this is because the degree of steepness when deltaf=fa-fr (fa:antiresonant frequency, fr:resonance frequency) of SAW resonator becomes small and constitutes an SAW filter will improve if an electrode thickness is thickened, as shown in drawing 3 and the drawing 4 . It is data of SAW resonator of transposition width-of-face 50lambda (lambda is the wavelength of SAW) of 50 pairs of logarithms, and IDT electrode. in addition, the drawing 4 -- IDT electrode -- For the black dot mark, a piezo-electric substrate is LiNbO3 of 64 degreeY cut-X propagation. Although it consists of a crystal, for the graph of a deltaf-(aluminum) electrode layer thick H property, and the white square mark, a piezo-electric substrate is LiTaO3 of 36 degreeY cut-X propagation. Although it consists of a crystal, it is the graph of a deltaf-(aluminum) electrode layer thick H property.
[0013] However, Hs and Hp Hs =Hp If it is simultaneously made thicker than the former in the status, the frequency margin in narrowing and a transit frequency band will also decrease to transit frequency bandwidth. Therefore, if it is the case where a decrement region is set to the low-pass side near the transit frequency band, or a high region side and it is the direction with a decrement region, for example, a high region side, it is the electrode layer thick Hs of an in-series SAW resonator. Thickening is desirable and it improves only the degree of steepness of the high region side edge section of a transit frequency band in that case.
[0014] Moreover, a piezo-electric substrate is LiTaO3. When it consists of a crystal, it is related with standardization thickness Hp/lambda and Hs/lambda (lambda is the wavelength of SAW). It is referred to as 0.01 <=|Hp/lambda-Hs/lambda|<=0.1 and a control of a thickness is difficult at |Hp/lambda-Hs/lambda|<0.01. Moreover, the effect of this invention is not demonstrated, it is easy to shift from the value (50ohms) which the impedance in the transit frequency band of an SAW filter should adjust with an external circuit in |Hp/lambda-Hs/lambda|>0.1, therefore the frequency deviation in a transit frequency band becomes large. Preferably, being referred to as 0.05 <=|Hp/lambda-Hs/lambda|<=0.1 is good.
[0015] A piezo-electric substrate is LiNbO3. It is referred to as 0.01 <=Hp/lambda-Hs/lambda<=0.2 when it consists of a crystal. In Hp/lambda-Hs / lambda< 0.01, a control of a thickness is difficult, the effect of this invention is not demonstrated, it is easy to

shift from the value (50ohms) which the impedance in the transit frequency band of an SAW filter should adjust with an external circuit in Hp/lambda-Hs / lambda> 0.2, therefore the frequency deviation in a transit frequency band becomes large. Preferably, being referred to as 0.05 <=Hp/lambda-Hs/lambda<=0.1 is good.

[0016] The SAW filter of this invention is a ladder type thing which the in-series SAW resonators 11a, 11b, and 11c which have IDT electrode of a couple are connected to an in-series wiring, and the parallel SAW resonators 12a and 12b which have IDT electrode of a couple are connected to the aforementioned in-series wiring and the parallel wiring during a grounding, and grows into them, as shown in drawing 5 (a). Moreover, it is applicable not only to the 2.5 step pi type of drawing 5 (a), the 2.5 step T type of (b), and the three step type of (c) but an one step type or the thing which made multi-stage connection more.

[0017] In this invention, it consists of aluminum or an aluminum alloy (an aluminum-Cu system, aluminum-Ti system, etc.), especially aluminum has high excitation luminous efficacy, and since a material cost is low, IDT electrode and the reflector of SAW resonator have it. [desirable] Moreover, IDT electrode is formed by the thin film forming methods, such as a vacuum deposition, the sputtering method, or CVD.

[0018] And the width of face of 50 to about 200 and an electrode finger is suitable for the logarithm of IDT electrode in that the spacing of about 0.1-10.0 micrometers and an electrode finger sets opening width of face's (transposition width of face's) of about 0.1-'s10.0 micrometers' and an electrode finger to about 10-'s150 micrometers acquiring the expected property as a resonator or a VCF. Moreover, if piezoelectric material, such as a zinc oxide and an aluminum oxide, is formed between the electrode fingers of IDT electrode, the resonance luminous efficacy of SAW improves and is suitable.

[0019] As a piezo-electric substrate for SAW filters, it is LiTaO3 of 36 degreeY cut-X propagation. LiNbO3 of a crystal and 64 degreeY cut-X propagation LiB4 O7 of 45 degreeX cut-Z [besides a crystal] propagation An electromechanical coupling coefficient is [a crystal etc.] large, and, for a parvus reason, a group-delay temperature coefficient is desirable. The thickness of a piezo-electric substrate has about 0.3-0.5 goodmm, a piezo-electric substrate becomes brittle in less than 0.3mm, and a material cost becomes large in 0.5mm **.

[0020] In this way, this invention raises the steep nature of the shape-factor section in the standup section or the falling section of a transit frequency band edge, sufficient frequency margin for the both sides of the shape-factor section is secured, and, as a result, it has a high yield and the operation effect of considering as the thing of a low cost.

[0021] In addition, this invention is not limited to the above-mentioned operation gestalt, and the various change in within the limits which does not deviate from the summary of this invention does not interfere at all.

[Translation done.]

EXAMPLE

[Example] The example of this invention is explained below. SAW filter F of the 2.5 step pi type of drawing 5 (a) was produced by following processes (1) - (5).
[0023] (1) LiTaO3 of 36 degreeY cut-X propagation On the wafer of the piezo-electric substrate which consists of a crystal, the resist was applied, the adhesion exposure machine using the ultraviolet-rays (Deep-UV) light source performed photo lithography, and the negative pattern of much SAW filter F was formed.
[0024] (2) On the aforementioned negative pattern, aluminum was formed with the electron-beam-evaporation machine.
[0025] (3) The lift off of the pattern of unnecessary aluminum was carried out in resist sublation liquid, and aluminum pattern of SAW filter F was formed.
[0026] (4) The process of (1) - (3) was repeated twice, and it is the standardization thickness Hs of the electrode of an in-series SAW resonator / lambda= 0.06 (Hs = about 2500**, lambda= about 4.4 micrometers), and the standardization thickness Hp of the electrode of a parallel SAW resonator / lambda= 0.08 (Hp = about 3500**), and was made to be set to Hp/lambda-Hs / lambda= 0.02.
[0027] (5) The package lid was put and closed, after having cut into each SAW filter F in the dicing method the wafer which patterning completed, having pasted up in the package for SMD (Surface Mounted Device:surface mount element), having fixed each SAW filter F by the epoxy resin and carrying out the ultrasonic bonding of the pad section of a package, and the pad section of SAW filter F with aluminum wire of 35microphi (diameter of 35 micrometers).
[0028] and the in-series SAW resonators 11a, 11b, and 11c and the parallel SAW resonators 12a and 12b -- 40 pairs and transposition width of face made [the logarithm of the IDT electrodes 1a and 1b] 30lambda (it is the wavelength of SAW and lambda is about 4.4 micrometers), and the number of electrode fingers of reflectors 2 ten by 20, parallel SAW resonator 12a, and 12b side by in-series SAW resonatorsa [11] and 11b and 11c side
[0029] Thus, the filter shape of produced SAW filter F is measured using a network analyzer, and the result is shown in drawing 2 . Drawing 2 (a) is this invention article, and becomes steep [the shape-factor section] compared with the conventional article of (b), the frequency span also becomes below a half and the frequency margin has doubled [more than].
[0030] Therefore, when 1000 SAW filter F was produced, the defective resulting from the aforementioned frequency margin was completely lost, and became about 100% of the yield.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The frequency characteristic of the SAW filter of this invention is shown, and (a) is the electrode layer thick Hs of an in-series SAW resonator. Electrode layer thick Hp of a parallel SAW resonator The graph of the |Z|-frequency characteristic when making it thin, The graph of the filter shape in the case of (b) corresponding to (a) and establishing a predetermined decrement region in the high region side of a transit frequency band, (c) is Hp. Hs The graph of the |Z|-frequency characteristic when also making a twist thin and (d) are the graphs of the filter shape in the case of corresponding to (c) and establishing a predetermined decrement region in the low-pass side of a transit frequency band.
[Drawing 2] The graph for (a) explaining the filter shape of the SAW filter of this invention and (b) are the graphs for explaining the filter shape of the conventional SAW filter.
[Drawing 3] Resonance frequency fr of the conventional general SAW filter It is the graph of the deltaf(=fa-fr)-frequency characteristic which shows the relation of antiresonant frequency fa.
[Drawing 4] It is the graph of the deltaf-electrode layer thick H property concerning this invention, and, for the black dot mark, a piezo-electric substrate is LiNbO3 of 64 degreeY cut-X propagation. Although it consists of a crystal, for a graph and the white square mark, a piezo-electric substrate is LiTaO3 of 36 degreeY cut-X propagation. It is a graph although it consists of a crystal.
[Drawing 5] The example of the ladder type SAW filter which can apply this invention is shown, and (a) is [a 2.5 step T type circuit diagram and (c of a 2.5 step pi type circuit diagram and (b))] three step type circuit diagrams.
[Drawing 6] The frequency characteristic of the conventional SAW filter is shown and (a) is Hp =Hs. The graph of the |Z|-frequency characteristic of a case and (b) are the graphs of a filter shape corresponding to (a).
[Drawing 7] It is for explaining the problem of the yield fall resulting from the conventional frequency margin, and the graph of the SAW filter number-frequency characteristic with which (a) shows the status of the high yield by the large frequency margin, and (b) are the graphs of the SAW filter number-frequency characteristic which shows the status that the yield fell by the narrow frequency margin.
[Description of Notations]
1a: IDT electrode
1b: IDT electrode
2: Reflector
3: Input terminal
4: Output terminal
11a: In-series SAW resonator
11b: In-series SAW resonator
11c: In-series SAW resonator
12a: Parallel SAW resonator
12b: Parallel SAW resonator

[Translation done.]

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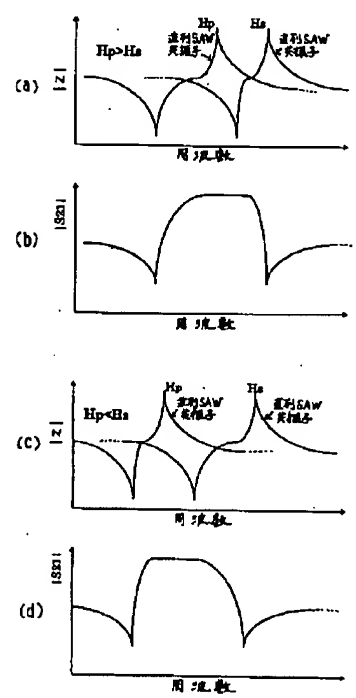
(54)【発明の名称】　弾性表面波フィルタ

(57)【要約】

【課題】通過周波数帯域端部のシェープファクタ部の急峻性を向上させ、その両側に十分な周波数マージンを確保し、その結果、高歩留りなものとする。

【解決手段】一対のＩＤＴ電極を有するＳＡＷ共振子が$LiTaO_3$からなる圧電基板上に複数個ラダー型に接続され、直列ＳＡＷ共振子の電極の規格化膜厚Hs ／λと並列ＳＡＷ共振子の電極の規格化膜厚Hp ／λとが、０．０１≦｜Hp ／λ－Hs ／λ｜≦０．１である。



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【特許請求の範囲】

【請求項1】ＬｉＴａO_3 結晶から成る圧電基板上の直列配線に一対の櫛歯状電極を有する直列弾性表面波共振子が接続され、前記直列配線と接地間の並列配線に一対の櫛歯状電極を有する並列弾性表面波共振子が接続されて成る、ラダー型の弾性表面波フィルタであって、前記直列弾性表面波共振子の電極膜厚をHs 、前記並列弾性表面波共振子の電極膜厚をHp 、弾性表面波の波長をλとした場合、これらの規格化膜厚Hp ／λ，Hs ／λが $0.01 \leqq |Hp/\lambda - Hs/\lambda| \leqq 0.1$ であることを特徴とする弾性表面波フィルタ。

【請求項2】ＬｉＮｂO_3 結晶から成る圧電基板上の直列配線に一対の櫛歯状電極を有する直列弾性表面波共振子が接続され、前記直列配線と接地間の並列配線に一対の櫛歯状電極を有する並列弾性表面波共振子が接続されて成る、ラダー型の弾性表面波フィルタであって、前記直列弾性表面波共振子の電極膜厚をHs 、前記並列弾性表面波共振子の電極膜厚をHp 、弾性表面波の波長をλとした場合、これらの規格化膜厚Hp ／λ，Hs ／λが $0.01 \leqq Hp/\lambda - Hs/\lambda \leqq 0.2$ であることを特徴とする弾性表面波フィルタ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、携帯電話等の移動体通信機器に内蔵される弾性表面波フィルタに関する。

【０００２】

【従来の技術】従来のラダー（梯子）型弾性表面波（Surface Acoustic Wave で、以下、ＳＡＷと略す）フィルタＦの回路図を図5に示す。図5（ａ）は2．5段π型、（ｂ）は2．5段T型、（ｃ）は3段型のものである。このようなラダー型ＳＡＷフィルタ（以下、ＳＡＷフィルタという）Ｆは、圧電基板（図示せず）上に、一対の櫛歯状電極（Inter Digital Transducerで、以下、ＩＤＴ電極という）１ａ，１ｂと、ＩＤＴ電極１ａ，１ｂのＳＡＷ伝搬路の両端に設けられた反射器２，２とから成るＳＡＷ共振子を、複数個形成することによって得られる。尚、（ａ）において、１１ａ，１１ｂ，１１ｃは直列ＳＡＷ共振子、１２ａ，１２ｂは並列ＳＡＷ共振子、３は入力端子、４は出力端子である。同様に、（ｂ）において、１３ａ，１３ｂ，１３ｃは直列ＳＡＷ共振子、１４ａ，１４ｂ，１４ｃは並列ＳＡＷ共振子であり、（ｃ）において、１５ａ，１５ｂ，１５ｃは直列ＳＡＷ共振子、１６ａ，１６ｂ，１６ｃは並列ＳＡＷ共振子である。

【０００３】そして、ＳＡＷ共振子はある特定の周波数で共振を生じるものであり、直列ＳＡＷ共振子と並列ＳＡＷ共振子をラダー型に接続をすると、図6（ｂ）のように、帯域通過フィルタが構成できる。図6（ａ）は、直列ＳＡＷ共振子と並列ＳＡＷ共振子のインピーダンス絶対値｜Ｚ｜－周波数特性を示し、それぞれ特定の周波数でインピーダンスが極大となる、所謂共振周波数が存在する。また、（ａ）において、Hp は並列ＳＡＷ共振子の電極膜厚、Hs は直列ＳＡＷ共振子の電極膜厚であり、従来Hp ＝Hs であった。尚、（ｂ）においてＳ２１は信号レベルに比例するパラメータである。

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【０００４】

【発明が解決しようとする課題】しかしながら、一般的に、ＩＤＴ電極等の導電膜の成膜工程数削減の理由から、ワイヤーボンディング用のパッド部を除いた導電膜の膜厚はすべて同一として作製していた。すると、通過周波数帯域、例えば８６９～８９４ＭＨｚの周波数帯域の近傍に所定の減衰域を設ける場合には、圧電基板材料に固有の定数、例えば電気機械結合係数等によって決定されるシェープファクタ部が緩やかで広いために、通過周波数帯域端部の立ち上がり部又は立ち下がり部で、十分な周波数マージンを確保することはできなかった。前記シェープファクタ部は、立ち上がり部の主要部分又は立ち下がり部の主要部分で、－３．５ｄＢ程度～－２０ｄＢ程度の領域である。

【０００５】すなわち、図6（ｂ）に示すように、通過周波数帯域の高域側端部の立ち下がり部で、所定のスペック周波数幅（２０ＭＨｚ）内にシェープファクタ部を収めて、その両側に十分な周波数マージンを確保するのが理想であるが、実際にはシェープファクタ部の高域側にはほとんど周波数マージンが存在しない。この場合、周波数マージンが狭いか存在しないために、以下のような問題点が生じていた。

【０００６】図7を用いてそれを説明する。同図は、ＳＡＷフィルタの個数とシェープファクタ部付近の周波数との関係を示し、図7（ａ）はシェープファクタ部（図示せず）が急峻なために、周波数マージンがシェープファクタ部の両側に十分存在している場合であり、この場合、製造プロセスの諸条件の変動によって周波数軸上を波形が平行移動することによるばらつき（製造偏差といい、図中の曲線部）を、スペック周波数幅内に収めることができる。一方、図7（ｂ）のように、前記ばらつきがほぼ一定であるとしても、シェープファクタ部がなだらかで広いため、周波数マージンがシェープファクタ部の両側に十分存在しておらず、その結果、前記ばらつきに対して相対的にスペック周波数幅が狭くなり、前記ばらつきのために、スペック周波数幅内からとび出す製品（スペックアウト品）が出てくる。従来、このようなスペックアウト品が３０％程度発生していた。

【０００７】従って、本発明は、通過周波数帯域端部の立ち上がり部又は立ち下がり部でシェープファクタ部の急峻性を向上させ、シェープファクタ部の両側に十分な周波数マージンを確保し、その結果、製造プロセスの諸条件の変動により周波数がばらついてスペックアウト品が発生するのを解消することを目的とする。

【０００８】

【課題を解決するための手段】本発明の弾性表面波フィルタは、ＬｉＴａO_3 結晶から成る圧電基板上の直列配線に一対の櫛歯状電極を有する直列弾性表面波共振子が接続され、前記直列配線と接地間の並列配線に一対の櫛歯状電極を有する並列弾性表面波共振子が接続されて成る、ラダー型の弾性表面波フィルタであって、前記直列弾性表面波共振子の電極膜厚をHs 、前記並列弾性表面波共振子の電極膜厚をHp 、弾性表面波の波長をλとした場合、これらの規格化膜厚Hp ／λ，Hs ／λが０．０１≦｜Hp ／λ－Hs ／λ｜≦０．１であることを特徴とし、このような構成により、通過周波数帯域端部の立ち上がり部又は立ち下がり部の急峻性を向上させる。

【０００９】また、本発明の弾性表面波フィルタは、ＬｉＮｂO_3 結晶から成る圧電基板上の直列配線に一対の櫛歯状電極を有する直列弾性表面波共振子が接続され、前記直列配線と接地間の並列配線に一対の櫛歯状電極を有する並列弾性表面波共振子が接続されて成る、ラダー型の弾性表面波フィルタであって、前記直列弾性表面波共振子の電極膜厚をHs 、前記並列弾性表面波共振子の電極膜厚をHp 、弾性表面波の波長をλとした場合、これらの規格化膜厚Hp ／λ，Hs ／λが０．０１≦Hp ／λ－Hs ／λ≦０．２であることを特徴とする。

【００１０】また、好ましくは、前記圧電基板が３６°Ｙカット－Ｘ伝搬のＬｉＴａO_3 結晶、又は６４°Ｙカット－Ｘ伝搬のＬｉＮｂO_3 結晶から成る。

【００１１】

【発明の実施の形態】本発明を図１により説明する。同図（ａ）は直列ＳＡＷ共振子の電極膜厚Hsを並列ＳＡＷ共振子の電極膜厚Hp よりも薄くしたときの｜Ｚ｜－周波数特性のグラフ、（ｂ）は（ａ）に対応したもので通過周波数帯域の高域側に所定の減衰域を設ける場合のフィルタ特性のグラフ、（ｃ）は並列ＳＡＷ共振子の電極膜厚Hp を直列ＳＡＷ共振子の電極膜厚Hs よりも薄くしたときの｜Ｚ｜－周波数特性のグラフ、（ｄ）は（ｃ）に対応したもので通過周波数帯域の低域側に所定の減衰域を設ける場合のフィルタ特性のグラフである。

【００１２】本発明において、Hs ，Hp はなるべく厚くすることが好ましく、これは、図３，図４に示すように、電極膜厚を厚くするとＳＡＷ共振子のΔｆ＝ｆａ－ｆｒ（ｆａ ：反共振周波数，ｆｒ ：共振周波数）が小さくなり、ＳＡＷフィルタを構成した場合の急峻度が向上するからである。尚、図４はＩＤＴ電極対数５０対，ＩＤＴ電極の交差幅５０λ（λはＳＡＷの波長）のＳＡＷ共振子のデータであり、黒丸印は圧電基板が６４°Ｙカット－Ｘ伝搬のＬｉＮｂO_3 結晶から成るもののΔｆ－（Ａｌ）電極膜厚Ｈ特性のグラフ、白四角印は圧電基板が３６°Ｙカット－Ｘ伝搬のＬｉＴａO_3 結晶から成るもののΔｆ－（Ａｌ）電極膜厚Ｈ特性のグラフである。

【００１３】しかしながら、Hs ，Hp をHs ＝Hp の状態で同時に従来よりも厚くすると、通過周波数帯域幅まで狭まり、通過周波数帯域内の周波数マージンも減少する。従って、通過周波数帯域近傍の低域側か高域側のいずれかに減衰域を設定する場合であって、減衰域のある方、例えば高域側であれば直列ＳＡＷ共振子の電極膜厚Hs のみを厚くするのが好ましく、その場合、通過周波数帯域の高域側端部の急峻度だけを改善する。

【００１４】また、圧電基板がＬｉＴａO_3 結晶から成る場合、規格化膜厚Hp ／λ，Hs／λ（λはＳＡＷの波長）に関して、０．０１≦｜Hp ／λ－Hs ／λ｜≦０．１とし、｜Hp ／λ－Hs ／λ｜＜０．０１では膜厚の制御が難しく、また本発明の効果が発揮されず、｜Hp ／λ－Hs ／λ｜＞０．１ではＳＡＷフィルタの通過周波数帯域でのインピーダンスが外部回路と整合すべき値（５０Ω）からずれ易く、そのため通過周波数帯域での周波数偏差が大きくなる。好ましくは、０．０５≦｜Hp ／λ－Hs ／λ｜≦０．１とするのが良い。

【００１５】圧電基板がＬｉＮｂO_3 結晶から成る場合、０．０１≦Hp ／λ－Hs ／λ≦０．２とする。Hp ／λ－Hs ／λ＜０．０１では膜厚の制御が難しく、また本発明の効果が発揮されず、Hp ／λ－Hs ／λ＞０．２ではＳＡＷフィルタの通過周波数帯域でのインピーダンスが外部回路と整合すべき値（５０Ω）からずれ易く、そのため通過周波数帯域での周波数偏差が大きくなる。好ましくは、０．０５≦Hp ／λ－Hs ／λ≦０．１とするのが良い。

【００１６】本発明のＳＡＷフィルタは、図５（ａ）に示すように、直列配線に一対のＩＤＴ電極を有する直列ＳＡＷ共振子１１ａ，１１ｂ，１１ｃが接続され、前記直列配線と接地間の並列配線に一対のＩＤＴ電極を有する並列ＳＡＷ共振子１２ａ，１２ｂが接続されて成る、ラダー型のものである。また、図５（ａ）の２．５段π型，（ｂ）の２．５段Ｔ型，（ｃ）の３段型に限らず、１段型又はより多段接続したものにも適用できる。

【００１７】本発明において、ＳＡＷ共振子のＩＤＴ電極及び反射器はＡｌあるいはＡｌ合金（Ａｌ－Ｃｕ系，Ａｌ－Ｔｉ系等）からなり、特にＡｌが励振効率が高く、材料コストが低いため好ましい。また、ＩＤＴ電極は蒸着法、スパッタリング法又はＣＶＤ法等の薄膜形成法により形成する。

【００１８】そして、ＩＤＴ電極の対数は５０～２００程度、電極指の幅は０．１～１０．０μm程度、電極指の間隔は０．１～１０．０μm程度、電極指の開口幅（交差幅）は１０～１５０μm程度とすることが、共振器あるいはフィルタとしての所期の特性を得るうえで好適である。また、ＩＤＴ電極の電極指間に酸化亜鉛，酸化アルミニウム等の圧電材料を成膜すれば、ＳＡＷの共振効率が向上し好適である。

【００１９】ＳＡＷフィルタ用の圧電基板としては、３６°Ｙカット－Ｘ伝搬のＬｉＴａO_3 結晶、６４°Ｙカット－Ｘ伝搬のＬｉＮｂO_3 結晶の他、４５°Ｘカット

－Z伝搬のLiB$_4$O$_7$結晶等が、電気機械結合係数が大きく且つ群遅延時間温度係数が小さいため好ましい。圧電基板の厚みは０．３～０．５mm程度がよく、０．３mm未満では圧電基板が脆くなり、０．５mm超では材料コストが大きくなる。

【００２０】かくして、本発明は、通過周波数帯域端部の立ち上がり部又は立ち下がり部でシェープファクタ部の急峻性を向上させ、シェープファクタ部の両側に十分な周波数マージンを確保し、その結果、高歩留り、低コストのものとするという作用効果を有する。

【００２１】なお、本発明は上記の実施形態に限定されるものではなく、本発明の要旨を逸脱しない範囲内で種々の変更は何等差し支えない。

【００２２】

【実施例】本発明の実施例を以下に説明する。図５（ａ）の２．５段π型のSAWフィルタFを、以下の工程（１）～（５）で作製した。

【００２３】（１）３６°Yカット－X伝搬のLiTaO$_3$結晶から成る圧電基板のウェハ上にレジストを塗布し、紫外線（Deep-UV）光源を用いた密着露光機によりフォトリソグラフィーを行ない、多数のSAWフィルタFのネガパターンを形成した。

【００２４】（２）前記ネガパターン上に、電子ビーム蒸着機によりAlを成膜した。

【００２５】（３）レジスト剥離液中で不要なAlのパターンをリフトオフし、SAWフィルタFのAlパターンを形成した。

【００２６】（４）（１）～（３）の工程を２回繰返し、直列SAW共振子の電極の規格化膜厚Hs／λ＝０．０６（Hs＝約２５００Å，λ＝約４．４μm）、並列SAW共振子の電極の規格化膜厚Hp／λ＝０．０８（Hp＝約３５００Å）であり、Hp／λ－Hs／λ＝０．０２となるようにした。

【００２７】（５）パターニングが完了したウェハをダイシング法で個々のSAWフィルタFにカットし、個々のSAWフィルタFをエポキシ樹脂でSMD（Surface Mounted Device：表面実装素子）用のパッケージ内に接着、固定し、３５μφ（直径３５μm）のAlワイヤーでパッケージのパッド部とSAWフィルタFのパッド部を超音波ボンディングした後、パッケージリッドを被せ封止した。

【００２８】そして、直列SAW共振子１１ａ，１１ｂ，１１ｃ及び並列SAW共振子１２ａ，１２ｂは、IDT電極１ａ，１ｂの対数が４０対、交差幅が３０λ（λはSAWの波長で、約４．４μm）、反射器２の電極指本数は直列SAW共振子１１ａ，１１ｂ，１１ｃ側で２０本、並列SAW共振子１２ａ，１２ｂ側で１０本とした。

【００２９】このようにして作製したSAWフィルタFのフィルタ特性を、ネットワークアナライザを用いて測定し、その結果を図２に示す。図２（ａ）は本発明品であり、（ｂ）の従来品に比べ、シェープファクタ部が急峻となり、その周波数幅も半分以下となり周波数マージンが２倍以上になっている。

【００３０】従って、SAWフィルタFを１０００個作製した場合、前記周波数マージンに起因する不良品は全くなくなり、ほぼ１００％の歩留りとなった。

【００３１】

【発明の効果】本発明は、ラダー型のSAWフィルタにおいて、直列SAW共振子の電極の規格化膜厚Hs／λと並列SAW共振子の電極の規格化膜厚Hp／λとが、所定の値で異なることによって、通過周波数帯域端部の立ち上がり部又は立ち下がり部でシェープファクタ部の急峻性を向上させ、シェープファクタ部の両側に十分な周波数マージンを確保し、その結果、製造プロセスの諸条件の変動により周波数がばらついてスペックアウト品が発生するのを防止し、高歩留りなものとするという効果を有する。

【図面の簡単な説明】

【図１】本発明のSAWフィルタの周波数特性を示し、（ａ）は直列SAW共振子の電極膜厚Hsを並列SAW共振子の電極膜厚Hpよりも薄くしたときの｜Z｜－周波数特性のグラフ、（ｂ）は（ａ）に対応し通過周波数帯域の高域側に所定の減衰域を設ける場合のフィルタ特性のグラフ、（ｃ）はHpをHsをよりも薄くしたときの｜Z｜－周波数特性のグラフ、（ｄ）は（ｃ）に対応し通過周波数帯域の低域側に所定の減衰域を設ける場合のフィルタ特性のグラフである。

【図２】（ａ）は本発明のSAWフィルタのフィルタ特性を説明するためのグラフ、（ｂ）は従来のSAWフィルタのフィルタ特性を説明するためのグラフである。

【図３】従来の一般的なSAWフィルタの共振周波数fr と反共振周波数faの関係を示す、Δf（＝fa－fr）－周波数特性のグラフである。

【図４】本発明に係わるΔf－電極膜厚H特性のグラフで、黒丸印は圧電基板が６４°Yカット－X伝搬のLiNbO$_3$結晶から成るもののグラフ、白四角印は圧電基板が３６°Yカット－X伝搬のLiTaO$_3$結晶から成るもののグラフである。

【図５】本発明を適用できるラダー型SAWフィルタの具体例を示し、（ａ）は２．５段π型の回路図、（ｂ）は２．５段T型の回路図、（ｃ）は３段型の回路図である。

【図６】従来のSAWフィルタの周波数特性を示し、（ａ）はHp＝Hsの場合の｜Z｜－周波数特性のグラフ、（ｂ）は（ａ）に対応するフィルタ特性のグラフである。

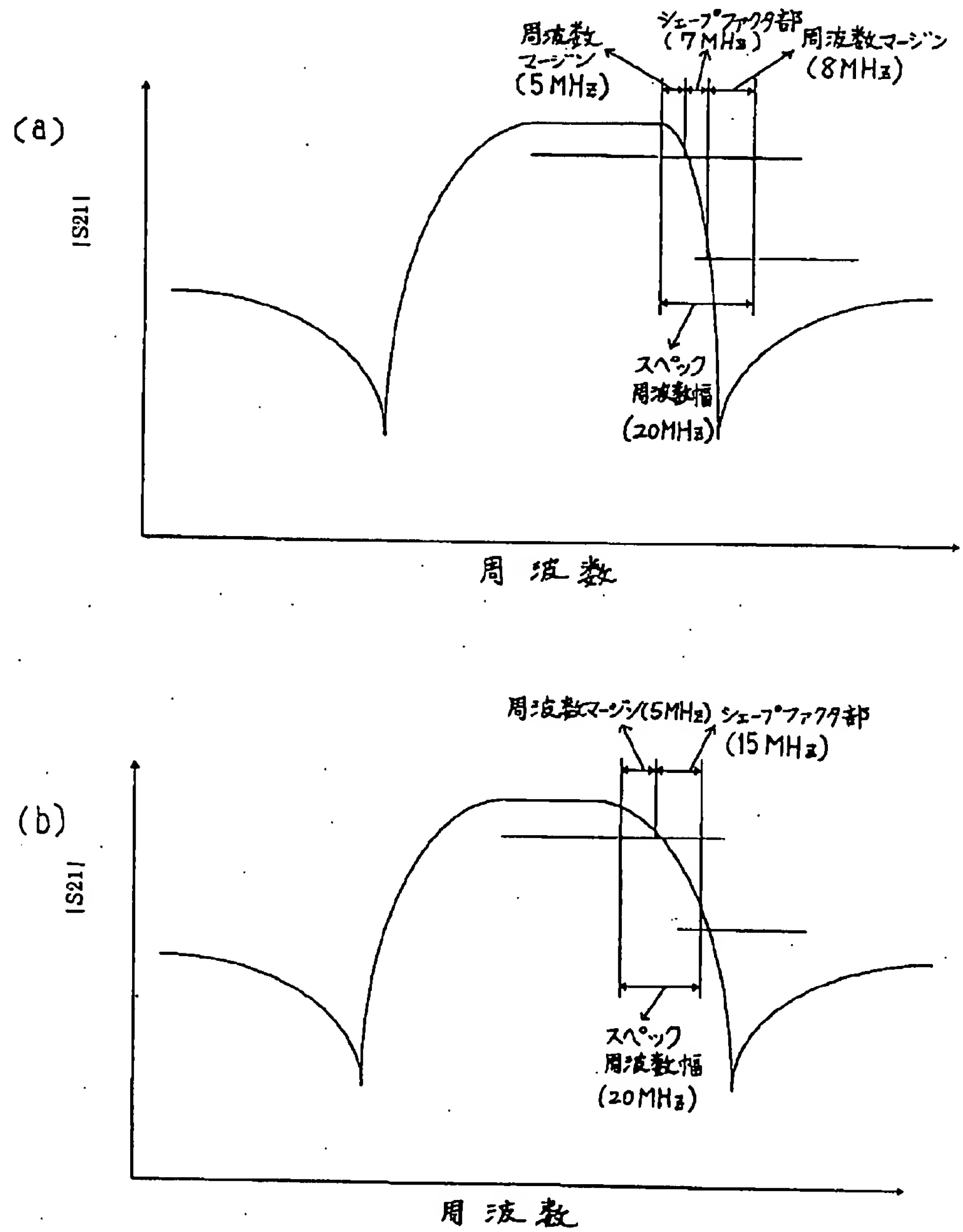
【図７】従来の周波数マージンに起因した歩留り低下の問題を説明するためのもので、（ａ）は広い周波数マージンによる高歩留りの状態を示すSAWフィルタ個数－

周波数特性のグラフ、（ｂ）は狭い周波数マージンによって歩留りが低下した状態を示すＳＡＷフィルタ個数－周波数特性のグラフである。

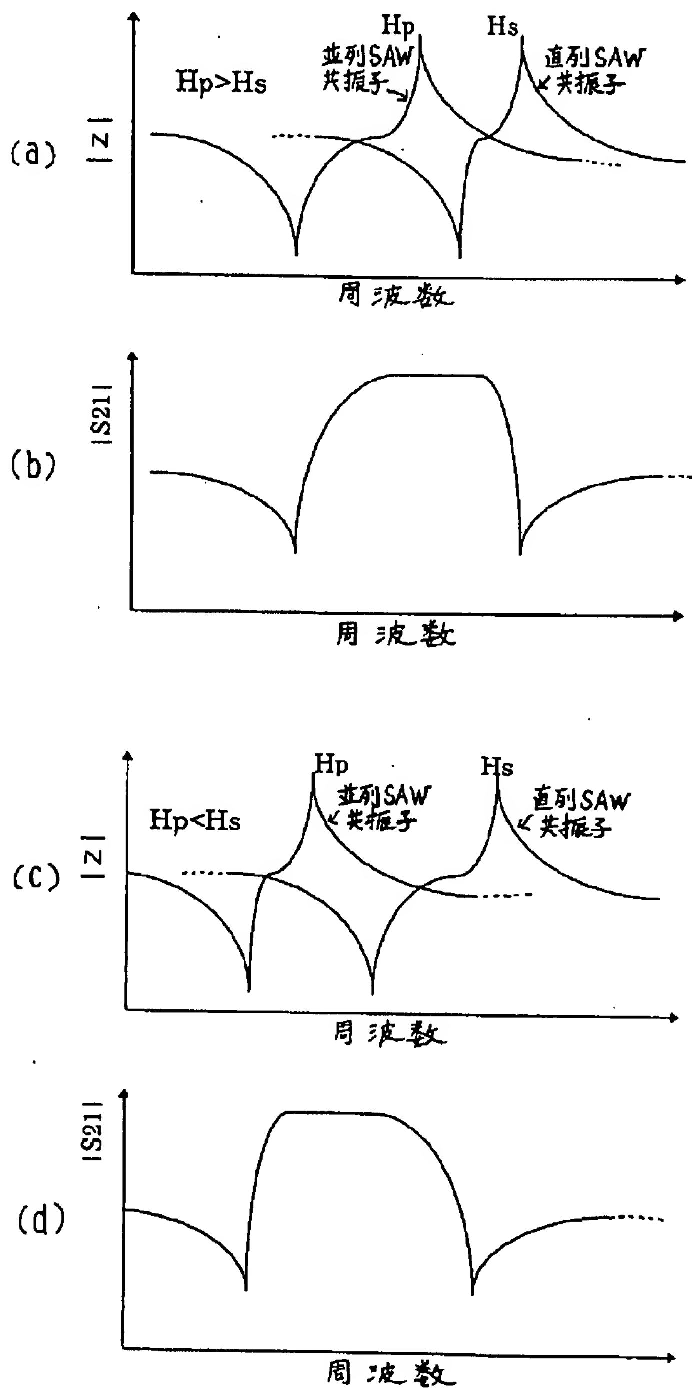
【符号の説明】

１ａ：ＩＤＴ電極
１ｂ：ＩＤＴ電極
２：反射器
３：入力端子
４：出力端子
１１ａ：直列ＳＡＷ共振子
１１ｂ：直列ＳＡＷ共振子
１１ｃ：直列ＳＡＷ共振子
１２ａ：並列ＳＡＷ共振子
１２ｂ：並列ＳＡＷ共振子

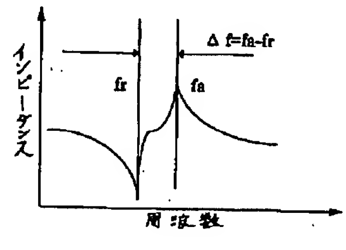
【図２】



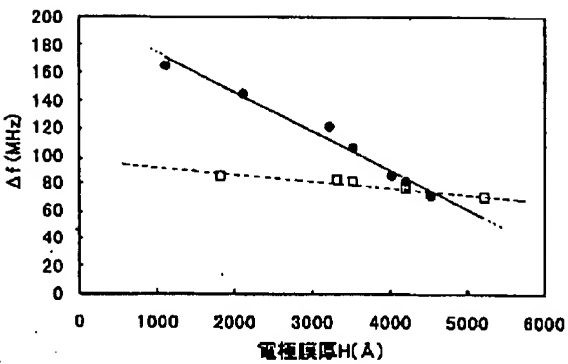
【図1】


(a)
Hp>Hs
|Z|
Hp
並列SAW共振子
Hs
直列SAW共振子
周波数
(b)
|S21|
周波数
(c)
Hp<Hs
|Z|
Hp
並列SAW共振子
Hs
直列SAW共振子
周波数
(d)
|S21|
周波数

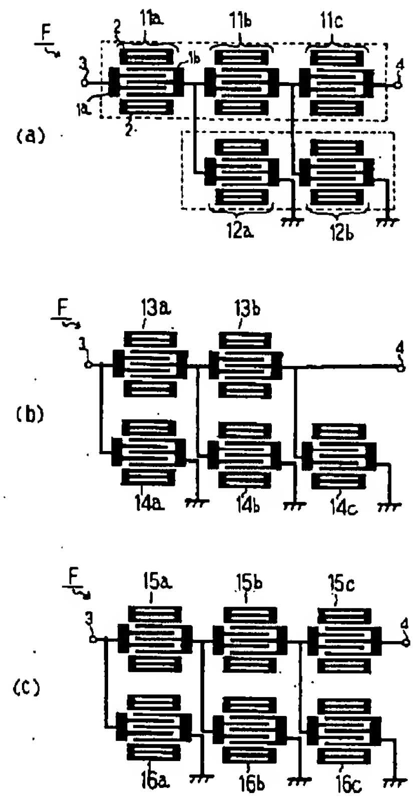
【図3】


インピーダンス
fr
fa
Δ f=fa-fr
周波数

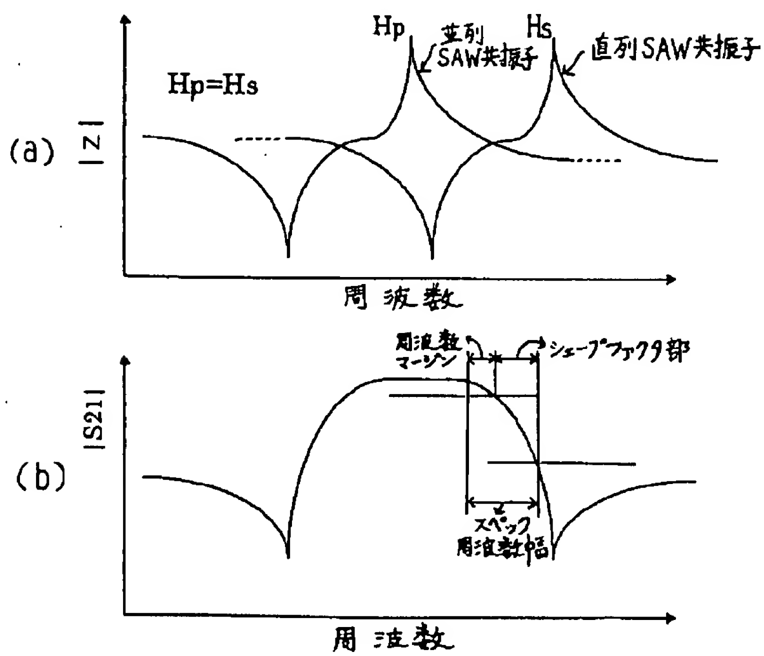
【図4】


200
180
160
140
120
100
80
60
40
20
0
Δf (MHz)
0
1000
2000
3000
4000
5000
6000
電極膜厚H(Å)

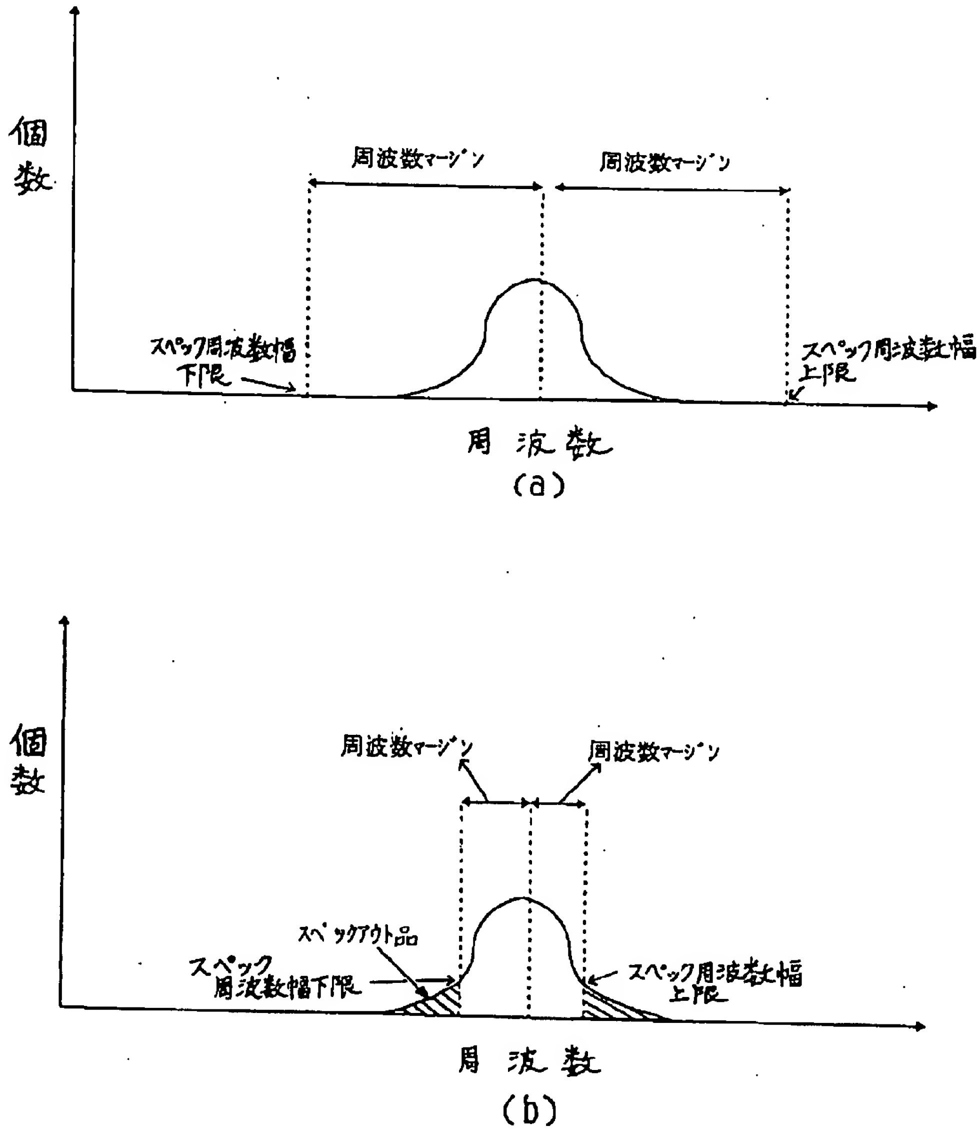
【図5】


(a)
F
11a
11b
11c
1b
1a
2
3
4
12a
12b
(b)
F
13a
13b
3
4
14a
14b
14c
(c)
F
15a
15b
15c
3
4
16a
16b
16c

【図6】


(a)
|Z|
Hp=Hs
Hp
並列SAW共振子
Hs
直列SAW共振子
周波数
(b)
|S21|
周波数マージン
シェープファクタ部
スペック周波数幅
周波数

【図7】


個数
周波数マージン
周波数マージン
スペック周波数幅下限
スペック周波数幅上限
周波数
(a)
個数
周波数マージン
周波数マージン
スペックアウト品
スペック周波数幅下限
スペック周波数幅上限
周波数
(b)